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NAVAL POSTGRADUATE SCHOOL

Monterey, California



THEESIS

A PROCESS FOR MAKING ON-GOING IMPROVEMENTS
FOR DISPENSING MEDICATION:
USING A TQM APPROACH

by

Bradley R. Bosch

June 1991

Thesis Advisor: Dan Trietsch

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A Process for Making On-Going Improvements for
Dispensing Medication: Using a TOM Approach

by

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from the

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ABSTRACT

This thesis is an examination of the workflow processes of the outpatient pharmacy at Silas B. Hays Army Community Hospital and stresses a TQM approach to identify acceptably improvement strategies. Through the application of statistical, technical and managerial techniques, an analysis is made for determining more effective and efficient methods for dispensing medication to the medical beneficiaries of the Army's Fort Ord region.

A detailed description of the outpatient pharmacy's operations define the parameters in which the operating manager's strategies must perform. This study is to facilitate the process for making on-going improvements and assist in creating a strategic integrating management system to achieve the goals of the hospital's administration and of the pharmacy department.

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INTRODUCTION

A. DESCRIPTION

The theme behind this thesis focuses on the process of dispensing medication orders from the outpatient pharmacy at Silas B. Hays Army Community Hospital. Primarily, the study looks at how prescription orders can be delivered with the least possible delay, at a zero defect rate while providing the highest level of quality health care to each and every patient.

"Silas B. Hays Army Community Hospital, Fort Ord California, is full accredited and certified by the Joint Commission on Accreditation of Hospitals (JCAH). This accreditation agency represents the American Hospital Association, the American Medical Association, and the American College of Physicians." [Ref. 1]

The general population of medical beneficiaries for Fort Ord's Army Hospital is estimated at 62,900 eligible recipients. The number of outpatient visits per month averages 36,700 and the inpatient bed capacity is 400. The hospital's average daily inpatient census reaches beyond 90 and the patient discharge rate averages above 800 per month. [Ref. 2]

The analogies that are expressed throughout this study, shall relate to the various problem areas identified within the framework of the outpatient pharmacy.

The chief complaints concerning the pharmacy are the long waiting lines; the time it takes to serve a customer; and the heavy congested traffic in the main lobby entrance to the hospital where the outpatient pharmacy is located.

The methodologies developed in this thesis utilizes both real and hypothetical data. Real data for this study was collected during a two hour period, February 1991, to obtain information concerning the processing time associated with filling prescribed medication orders. Additional information on the general operations of Silas B. Hays Community Hospital was collected through various interviews of hospital officials, as well as information provided by them in writing for the purpose of conducting this study. [Ref. 3]

The methodologies used in this study will depict the kind of on-going improvements that can provide better services to the community. Furthermore, this study should present itself as a model for making other quality changes and provide the necessary documentation for making improvement changes.

B. SCOPE

Chapter I is a detailed description on how the management of the outpatient pharmacy operates and the parameters in which the operating manager must perform. These descriptive factors are prevalent and can be found in many pharmacies throughout military treatment facilities. They can be used to

compare and evaluate performance standards. Nevertheless, developing performance standards should not be the goal, but rather a means to develop an operating strategy.

Chapter II is a workflow analysis of the outpatient pharmacy. A description of a queueing study (February, 1991) helps define the overall process of filling customer drug orders. The discussion in this chapter analyzes the drug order filling process in detail. As the process unfolds capacity levels of the various work stations are identified. The similarities between the drug order filling process and a manufacturing process help qualify these findings.

Chapter III is a determination of source defects and their relationship with inspection errors. Presently, the outpatient pharmacy has a double inspection policy. This policy requires that two pharmacists must check each new prescription prior to customer delivery. This chapter argues that a double inspection policy can actually lead to an increase in the number of errors in filling prescription orders. When inspection biases are eliminated an increase in the delivery of quality health care results.

Chapter IV presents an array of improvement strategies that are designed to meet the goals of the outpatient pharmacy. Three bottom line measurements (Throughput, Inventory and Operating expenses) are defined as to how they would apply to the drug order filling process. Improvement strategy opportu-

nities are analyzed to consider the impact that a change may have on satisfying the pharmacy's customers.

Chapter V looks at the material handling and facility layout of the outpatient pharmacy. The discussion evolves around the general characteristics of design and the layout of the various departmental components. Process and product layout, their relationship between the storage of material items is defined, as is the pattern in which those items flow.

Chapter VI is an integrating effort to introduce total quality management as a means in which to build a foundation for making continuous on-going process improvements. This chapter is a "Guide for Implementing Improvements: A TQM Approach." It stresses the importance of managerial understanding and commitment to the TQM process; employee education and training on the principles of TQM; the development and implementation of improvement strategies; and the monitoring and maintenance of improvement programs.

Through integration of various TQM statistical, technical and managerial techniques, patient waiting time for having an order filled by the outpatient pharmacy can be effectively reduced, and the heavy traffic through the hospitals main corridor can be regulated. Greater customer satisfaction can be achieved while delivering a higher quality product to the overall patient population.

I. SYSTEM DESCRIPTION OF THE OUTPATIENT PHARMACY

The function of the outpatient pharmacy at Silas B. Hays Army Hospital is twofold:

- First, to supply all medications as prescribed by proper authority at a zero error rate.
- Second, to deliver all medication orders with the least possible delay. [Ref. 4]

It is also the goal of the hospital's administration to reduce the long waiting lines to relieve the heavy traffic in the main lobby. This problem is a perceptual concern of presenting a poor image of the hospital.

Fort Ord's outpatient pharmacy uses an elaborate system of checks and balances to ensure there are no errors in dispensing medications to the medical beneficiaries in their region. This chapter describes how the outpatient pharmacy operates on a day-to-day basis to achieve these goals.

The normal operating hours for the pharmacy are from 0900-1700 for prescription drop off and from 0900-1800 for pick-up of a medication order. The pharmacy is closed over the weekends and on holidays.

Medication orders arrive at the pharmacy on various types of prescription forms. However, not all medications that are ordered are controlled. For instance, some medications are over-the-counter (OTC) drugs. These drugs may be ordered on

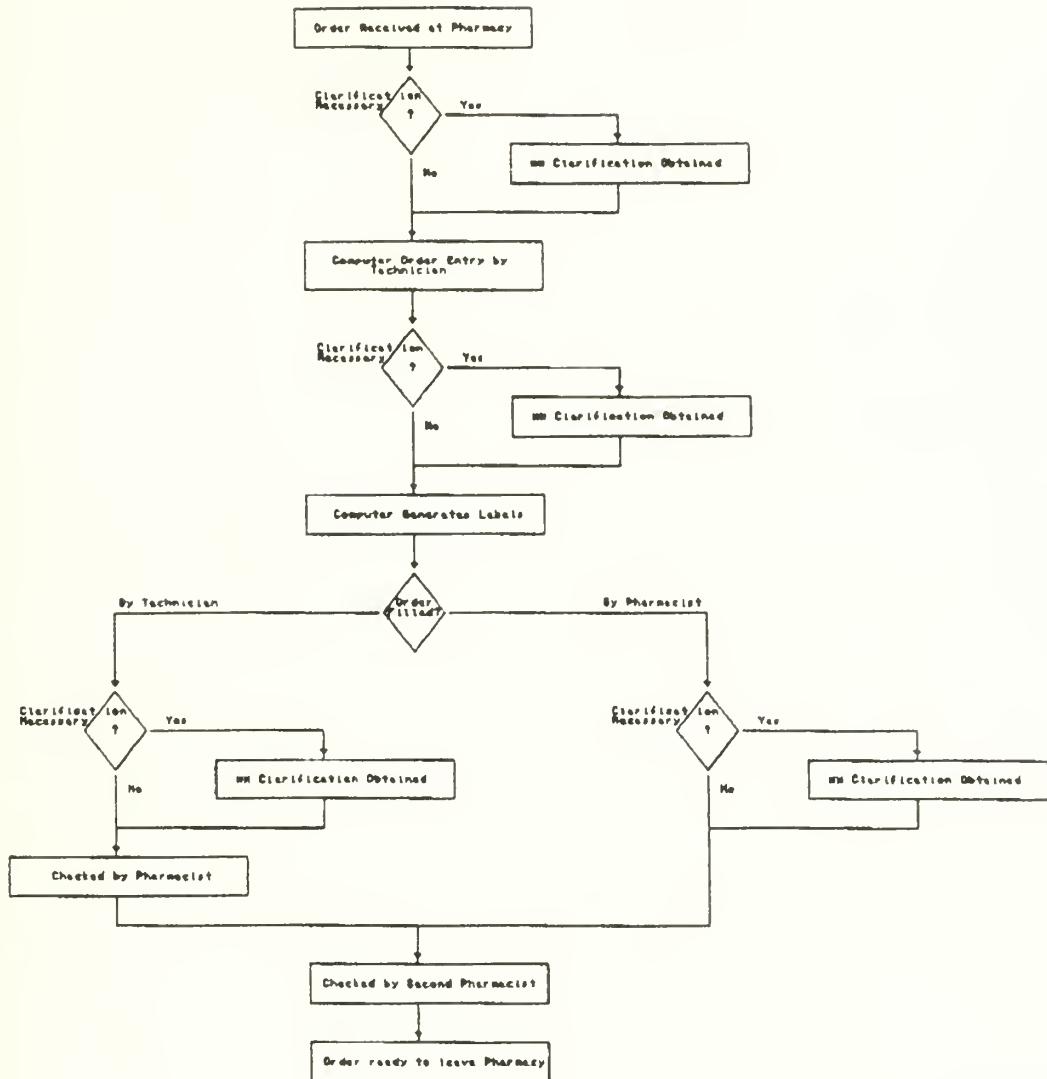
a blue prescription form which can be filled immediately upon receiving service at the front window. Other prescription forms allow for either a single prescription drug or multiple drug items to be ordered.

In most cases, patients are served on a first-come-first-serve basis. However, military personnel in uniform are given front of the line privileges when seeking services at the outpatient pharmacy. If a medical emergency does occur the higher priority would be handled accordingly and without delay.

Most medication orders filled by the outpatient pharmacy are considered non-emergencies. By design, other divisions of the pharmacy department (i.e., in-patient pharmacy or bulk pharmacy) are to provide the necessary services to handle the emergencies that occur day-to-day.

Figure 1.1 shows the normal flow of a drug order through the outpatient pharmacy. There is redundancy in the system that requires prescription clarification at all stages throughout the order process.

Most drug orders are presented at the pharmacy service window and a receipt is given to the patient. Receipt numbers are issued in numerical sequence. The pharmacy uses a call board numbering system to notify a patient when their prescription order is ready to be picked up.



** Clarification is often obtained by calling the attending physician; consulting another pharmacist; referring to a current drug manual; or by obtaining additional information from the patient.

Figure 1.1: Flow Diagram of a Drug Order Through the Outpatient Pharmacy

A patient may have access to the pharmacy system through two service lines. The first line is dedicated to prescription refills and the second line is only for new prescription orders. Some orders are received through facsimile directly from a ward where a patient has just been discharged.

The outpatient pharmacy system is computerized and as drug orders pass from the service window, they then are entered into the pharmacy database by a computer operator. Orders that arrive at the service window or the computer terminal are at times unclear and additional inspection may be required.

When medication orders have been entered into the pharmacy database the computer generates a label for each prescribed medication. The written prescription forms are then passed to the pharmacy technicians to be filled. Nevertheless, the computer operators are responsible for printing these labels and tend to batch or collect them. Medication orders are often filled from the written prescription rather than a computer generated label. Therefore, a technician may again have to clarify an issue that had already been clarified earlier.

Medication orders are spread out on an assembly line to be filled. They are filled by either a pharmacy technician or a pharmacist. Normally a pharmacist only fills an order when the assembly line begins to backlog.

Every new prescription order is checked by two pharmacists before leaving the pharmacy. A refill order is only checked by one pharmacist.

The batching of labels sometimes causes delays. If an order that has been filled directly from the prescription is later considered invalid, the processing time expended on filling that order has been wasted. When the system is able to operate without backlog, the written prescription is accompanied with a label to the assembly line for processing and there is less chance of making errors.

The total amount of service time required to fill an order may vary. For instance, some orders require routine drugs that are frequently ordered, counted and pre-packed ahead of time. Other orders require medications which must be drawn from stock and counted at the time the order is being filled. Some customers may have fewer prescriptions than others and require less service time.

Narcotics and other types of controlled substances are often delayed for control purposes. Narcotic orders are separated from a customer's regular order and consolidated later on when the order has been completed.

Many of the routine drugs that are not pre-packed are placed in baker cell machines and counting is done automatically. These baker cells are conveniently located and are in close proximity to the filling station.

Inspection of an order requires that the drug is checked against the written prescription form; that the label indicates the proper contents of the prescription bottle; that the manufacturing company's code number matches the code number for the particular drug that was ordered; that this code number appears on the prescription label; and that the medication is being given to the right patient. Afterwards, two pharmacists must record their initials on each prescription to indicate that this inspection was properly conducted.

All drug orders can then be consolidated and transferred to the pick-up area. Consolidation is accomplished by the markings that are put on the receipt when the customer first turned in his/her drug order. An identical receipt number which matches the number given to the customer follows the drug order throughout the filling process. Pharmacy employees can easily determine by these markings if any prescription from a customer's order is missing.

Clarification of a drug or drug order is often obtained by calling the prescribing physician; by contacting a station nurse on the ward where a patient had previously been under medical care; by consulting a professional drug manual; or through questioning the patient concerning the legitimacy of an order or other health related concerns regarding a prescribed medication.

Some of the general problems related to filling a medication order are listed below:

- An illegible or unclear written prescription.
- An unsigned prescription by a qualified medical officer or other authorized individual.
- The medication was prescribed earlier and a duplication of the order exists.
- A patient attempts to refill a prescribed medication prior to the time an order can be reasonably refilled without raising concerns of potential drug abuse.
- A suitable substitute is on hand; nevertheless, authorization to use the substitute must be obtained.
- A patient expresses legitimate concerns toward taking a specific medication.
- Required information on the back of a prescription is incomplete and pertinent information must be obtained before an order can be filled.

The flow of drug orders through the outpatient pharmacy is often disrupted. In a separate observational study, computer operators were often distracted by telephone calls and various questions concerning the clarification of an order. These operators were also scheduled to break for lunch at peak operating times without being properly relieved. Training of a new computer operator is sometimes done at peak hours of operation.

The service and pick-up windows are usually staffed by volunteers of the American Red Cross. When a patient's drug order is ready, the volunteer matches the customer's receipt number with the receipt that is on the customer's drug order. These individuals are extremely important to the overall function of the outpatient pharmacy due to budgetary constraints that are placed on the hiring of skilled and semi-skilled workers.

Most workers in the outpatient pharmacy are GS scale government employees. They range from non-skilled labor to the highly skilled professional pharmacist. Through the efforts of government contracting additional professional hire is made available to the pharmacy department.

The military officers assigned to the pharmacy, range between O-3 through O-6. They are normally fully trained and licensed pharmacists. The military pharmacy technicians are semi-skilled enlisted personnel who range between the ranks of E-3 through E-6.

Military enlisted personnel are required to stand additional military duties. However, this duty is not related to their job in the pharmacy. This policy is in contrast to the outpatient pharmacy's limited hours of operation. Mostly due to the lack of available staff personnel, the pharmacy is unable to provide the necessary support to extend their existing hours of operation.

Personnel are assigned to other divisions within the pharmacy department. The inpatient pharmacy provides all drug orders including IV medications for all in-patients during their medical stay at Fort Ord's Army Community Hospital. In addition, the inpatient pharmacy provides services to the emergency room during weekends when the outpatient pharmacy is closed.

The bulk pharmacy is the hospital's ready supply store. A ward or other service department of the hospital can pick up large quantities of an item at the bulk pharmacy rather than ordering a smaller quantity through one of the other pharmacies. A small pharmacy operated by the emergency room is kept well stocked by bulk pharmacy personnel.

The outpatient pharmacy's operating strategy is designed to ensure the delivery of all medication orders with the least possible delay and that all medications prescribed by proper authority are supplied at a zero error rate. The system described in this chapter is the process Fort Ord's Army Community Hospital uses to obtain these goals in dispensing medications to the medical beneficiaries in their region.

II. WORKFLOW ANALYSIS OF THE OUTPATIENT PHARMACY

A two hour study was conducted at Silas B. Hays Army Community Hospital's outpatient pharmacy for the purpose of collecting data concerning the processing time it takes to fill a medication order. This study began at exactly 9:30 a.m., recording each patient's arrival time and continued until 11:30 a.m. Only prescription orders for arrivals during this two hour period were tracked throughout the entire drug order filling process.

A. QUEUEING ANALYSIS

At arrival each patient was asked to participate in this study. The time they arrived was recorded in the upper left hand corner of each prescription. A queue number was assigned to each prescription form and the number of prescriptions that were on an individual script was counted. A patient number was also assigned for accounting purposes.

Example: Patient #26 presented two prescription forms to be filled. The time the patient arrived was recorded and the prescriptions were given queue #32 and queue #33. There were four prescribed medications on queue script #32 and two prescribed medications on queue script #33.

As each patient was served at the front window, the time was machine stamped on the back of each prescription form. The receipt number was highlighted in yellow in order to

differentiate the prescriptions in the study from all the rest.

A timekeeper stationed next to the computer operator documented the exact time that a prescription order was entered into the pharmacy database. This time was recorded directly under the machine stamped time that was collected at the front window. A drug order at this point was ready to be matched with a label that was to be generated by the computer. The label and the written prescription were then transferred to the pharmacy assembly line to be filled.

Another timekeeper was stationed at the end of the assembly line to record the time a prescription order was completed. This time was recorded only after all prescriptions were inspected by two pharmacists and the patient's entire order had been consolidated.

An American Red Cross volunteer was stationed at the pick up window to record the time a patient picked up his/her prescription order.

All prescriptions that were part of this study were collected and recorded into one record book. There was a total number of 186 prescription forms presented to the pharmacy service window. There were 290 prescribed medications for 139 customers.

A queueing observer noted that two customers reneged after entering the service line and four customers balked

before actually entering the line. During this study one worker was assigned to the service window; two computer operators were entering information into the pharmacy database; two pharmacy technicians were filling orders; three pharmacists were filling prescriptions and checking for accuracy; and a volunteer was assigned to the pick-up window.

Thirty-one customers had over-the-counter prescriptions that could be filled at the service window immediately. Thirteen of these customers had other prescriptions and still had to wait for the rest of their order to be completed.

The volunteer at the pick-up window failed to record times for 33 customers. Nevertheless, of those that were recorded 25 customers had waited until the next day to get their prescriptions. Eight customers picked their medication up after 3:30 p.m. Overall, 39% of the workload was not picked up by the pharmacy's customers until several hours after the work had been processed.

When the last prescription order in the queueing study was completed, the cumulative processing times at the various work stations were as follows:

Customer Service Window:	128 minutes
Computer Terminal Station:	184 minutes
Prescription Assembly	
Production Line:	174 minutes

The study included arrivals during a period of two hours (exactly 120 minutes) and a total of 139 customers participat-

ed. Therefore, the effective customer arrival rate μ is 139/120 which calculates to be 1.158 customers per minute.

TABLE I takes a closer look at the workflow of the outpatient pharmacy. Beginning with queue script #147 and ending with queue script #169, the service times for 15 customers are compared on a parallel basis as their orders are being processed. (See Appendix A.)

A customer may have more than one medication prescribed for them and may present more than one prescription form at the service window. Nevertheless, the sequence of events leading to the completion of a number of customer orders can be simultaneously followed and evaluated.

In an 11 minute span 15 customers had arrived at the outpatient pharmacy. They were served at the front window in a matter of 9 minutes. It took two computer operators 43 minutes to enter the necessary information into the pharmacy database and 23 minutes to fill the orders. The total processing time for these 15 customers was 86 minutes.

Over 50% of all the processing time was spent at the computer terminals. Arrival time to service time at the front window averaged 9.43 minutes. The time a patient's order traveled from the service window until it was entered into the pharmacy database averaged 44.35 minutes. The time between

TABLE I
SAMPLE WORKFLOW ON A PARALLEL BASIS

ARRIVAL		WINDOW		COMPUTER		FILL	
Time	Customer	Time	Customer	Time	Customer	Time	Customer
1113	1,2	1123	1,2,3,4	1153	1	1230	2
1114	3,4	1124		1154	2	1231	
1115		1125	6	1155		1232	1
1116	5	1126	5	1156	3	1233	
1117	6	1127	8	1157		1234	4
1118	7,8,9	1128	7,10	1158		1235	3
1119	10	1129	9	1159	4	1236	
1120	11,12	1130	11,12,13,14	1200		1237	5,6
1121	13	1131	15	1201		1238	
1122	14			1202		1239	7
1123	15			1203		1240	8,9,10
				1204	5	1241	12
				1205		1242	
				1206		1243	
				1207	6	1244	
				1208	8	1245	11
				1209		1246	13,14
				1210	7	1247	
				1211	10	1248	
				1212		1249	
				1213		1250	
				1214	9	1251	
				1215		1252	15
				1216			
				1217			
				1218			
				1219			
				1220			
				1221			
				1222	12		
				1223			
				1224			
				1225	13		
				1226	11,14		
				1227			
				1228			
				1229			
				1230			
				1231			
				1232			
				1233			
				1234			
				1235	15		

the order to be entered into the database and the time taken to complete the customer's order averaged 27.81 minutes. (See TABLE II.)

TABLE II - STATION-TO-STATION SERVICE TIME

A	B	C	D	E	F
1	10.5	30.5	37	2	78
2	10	31	36	1	77
* 3	8	33	39	3	80
* 4	9	34	35	6	78
5	11.5	38	33	7	82.5
6	8	42	30	3	80
* 7	10	42	29	1	81
8	9	41	32	2	82
* 9	11	46.3	24.7	3	82
10	9	44	28	2	81
11	10	56.5	16.5	2	83
12	10	52	19	2	81
13	9	55	21	1	83
* 14	8.5	56	20	3	84.5
15	8	64	17	3	89

* Orders picked up after 3:30 p.m. or the next day.

(A) Customer number; (B) Queueing line to arrival at service window time; (C) service window time to computer entry time; (D) Computer entry time to fill time; (E) Number of prescriptions per customer; (F) Total processing time per customer.

The fifteen customers in this sample each had an average number of 2.73 prescriptions. The total processing time for each customer ranged between 77-89 minutes, averaging 81.5 minutes per customer. Note that five of these customers picked up their order after 3:30 p.m. or on the following day.

The 15 customer orders began building up in front of the computer terminals. The result was a creation of unfilled orders. This inventory of unfilled orders then carried into the next step of the process, resulting in idle time or lost time to personnel who were filling prescriptions orders. [16]

TABLES I and II illustrate how close inventory is linked to the throughput of filling medication orders. In order for the pharmacy to increase throughput, the inventory of unfilled orders at the computer terminals must be reduced.

The information obtained during the two hour queueing study in February, 1991, has been compiled and recorded in Appendix A. The information was sorted using Minitab on the mainframe computer at the Naval Postgraduate School, Monterey, California.

B. THE BOTTLENECK

In a separate study of the suspected bottleneck station (i.e., computer operations), two operators were timed separately. While timing operator #1, the pharmacy department was running the prior week reports. Computer response time was very slow.

Near the end of recording the service times for operator #1, action was taken by pharmacy personnel to stop the printing of those reports. Normal computer response time was restored for the remainder of the time recorded study.

During the study the computer operators were interrupted a number of times. These interruptions included in-coming and out-going telephone calls; an operator being away from the work station while resolving or clarifying a problem with an order; and answering a number of questions that forced them to stop making entries into the computer database.

TABLE III shows the service times for the two computer operators and the quantitative findings of the study.

TABLE III
COMPUTER OPERATORS' SERVICE TIMES

Service time while reports were running:

Operator #1:

# of Customers:	40
# of Rx's:	74
Total Time:	90.18 minutes
Service time:	1.22 minutes/Rx
	2.25 minutes/customer

Service time under normal operating conditions:

Operator #1:

# of Customers:	14
# of Rx's:	24
Total Time:	13.65 minutes
Service Time:	.57 minutes/Rx
	.98 minutes/customer

Operator #2:

# of Customers:	84
# of Rx's:	129
Total Time:	100.62 minutes
Service Time:	.78 minutes/Rx
	1.20 minutes/customer

Total Disruption Time:

# of Phone Calls:	44
# of Other Disruptions:	12
Total Disruption Time:	20.42 minutes

Operator #1 served 54 customers in 104 minutes, while operator #2 serviced 84 customers in 100.62 minutes. Averaging everyone over the total time for both operators (138/204.45) the service rate, (μ) for each operator, is estimated to be .675 customers/minute.

Noting that pharmacy personnel had taken special action to increase computer response time the overall service rate was increased by 40%. For the purpose of this study total computer time was averaged regardless of the activities that were taking place in the pharmacy.

If all customer prescriptions including over-the-counter medications are processed immediately, the arrival rate that was previously calculated would remain unchanged. But since 18 of the 31 customers were not required to wait (were service at the front window), the effective arrival rate at the bottleneck station could be effectively reduced. A concept similar to the express line at the grocery store could be easily established. By using a simple heuristic, the outpatient pharmacy could discriminate toward wasting computer service time on prescription orders for customers that are not waiting or have already been served.

The decrease in the effective arrival rate after establishing such a policy would significantly reduce the level of inventory of unfilled prescriptions building up in front of the computer terminal station. At the present time, however,

the outpatient pharmacy chooses to include over-the-counter prescriptions immediately with the existing inventory.

In the workflow analysis of the pharmacy's drug order filling process, similarities between the typical manufacturing process are very noticeable (see Figure 2.1).

Raw Material ---> Work-in-Process ---> Finished Goods

Figure 2.1
Typical Structure Of A Manufacturing Process

In essence, the receipt of a customer's order at the pharmacy service window is the same as receiving raw material because each prescription must be properly processed. This involves numerous activities such as the entering of information into the computer database; assembly and sub-assembly of the drug order using stock and other raw materials carried by the pharmacy; and inspection of the final product before dispensing the medication to the customer.

The outpatient pharmacy serves a demanding market, requiring that all medication orders be delivered in a reasonable period of time and at a zero error rate. Uncertainty of demand is reflected by the needs of each customer and the resources that are required in order to complete a customer's order. Therefore, the pharmacy's response to patient demands must be directly proportional to the number of

prescriptions in process. By effectively reducing the amount of work-in-process, the level of customer satisfaction can be increased.

III. DETERMINATION OF SOURCE DEFECTS AND THEIR RELATIONSHIP WITH INSPECTION ERRORS

Given the elaborate system of checks and balances of the drug order filling process at Fort Ord's outpatient pharmacy, errors are still reported. Some of the errors that still occur are: giving a patient the wrong medication; placing the wrong medication in a baker cell; computer processing errors; and inadvertent errors by the first or second inspector, or by a pharmacy technician who may have filled an order. [Ref. 5]

Other types of errors may include: inventory errors, like when a specific medication is not in stock and a prescribed medication cannot be filled; or surprise errors, when something unexpectedly occurs in the pharmacy that may require maintenance and/or repair. There can also be errors surrounding the consolidation of a medication order; the forgetfulness on the part of a pharmacy employee; misinformation or errors due to lack of written standards; errors due to misunderstanding between pharmacy and medical staff personnel; and errors caused by negligence or employee sabotage. [Ref. 6]

It's not fair to say that all errors are caused by people. Nevertheless, most of the errors listed above are due to the kind of mistakes that individuals make all the time. Volunteers can make mistakes because of lack of experience or education. These are referred to as amateur errors. They may

not understand something that a skilled or semi-skilled worker knows or has acquired through special training. Their mistake is not committed purposefully, rather they just don't fully understand the procedure.

Some errors are due to negligence. Two inspectors who are equally responsible for the inspection of a product may choose to ignore certain rules under some circumstances. Thinking that the other inspector will identify a potential error in a medication order, the second inspector may only quickly scan a product for obvious errors.

Lack of standards create potential errors. We may leave too much discretion to workers who are not fully trained to perform certain duties expected of them. Surprise errors are always very difficult to deal with. Unexpectedly a computer may malfunction or a baker cell may become inoperable. It is important to build-in the necessary safeguards in order to keep surprise errors to a minimum. Employees can become overwhelmed with their duties and responsibilities. Proper safeguards must be in place to prevent an individual from sabotaging or intentionally committing gross errors.

Mistakes like those listed above can lead to a patient receiving the wrong medication. Improperly filling a medication order could cause bodily harm or even death. The goal is to deliver all medication orders with the least possible delay and to supply those medications at a zero error rate. The

question is, "Can such a goal really be achieved? And if so, HOW?"

Special studies into such matters have shown that "with prolonged inspection periods it is commonly observed that fault detection deteriorates as a function of time." The rate of deterioration reportedly drops very rapidly, in some instances as much as 40% in as little as 30 minutes. [Ref. 7]

Experts suggest that a random or independent glimpse search method often becomes the case. An inspector may view an item very quickly to first determine if a fault exists. If a fault does exist, then that inspector will fixate his search more carefully. When he is able to confirm that an item is in error, he then rejects the item. In the case where a pharmacist discovers an error, work becomes disrupted until the problem is resolved. [Ref. 8]

If the inspector does not see a fault in the initial search, the item will be viewed more carefully if time permits. Otherwise, the inspector will only look at the fault areas that are considered most important or more likely to be found in error. The inspector who is under great pressure to decrease overall service time is more likely to find an item acceptable right after the initial search.

When time permits a pharmacist will look closer to determine if a drug order is acceptable. When two pharmacists are involved in the same inspection, the chances increase that

an order will be found acceptable when in fact the order is defective. This becomes true because two people cannot be held accountable for the same inspection.

In the case of inspecting medication orders for accuracy, there is a high probability that one or more of the inspection criteria listed in Chapter I may be overlooked. Drury and Fox, experts in the field of human reliability and quality control, suggest, "that scanning may incorporate biases away from the theoretically optimal search and may be the cause of surprising irregularities in the level of efficiency which appear from time to time." [Ref. 9]

It can be argued that by employing an additional inspector such an action in itself, can cause an increase in errors. Furthermore, such an argument goes on to say that maybe there can actually be a decrease in the number of errors when there is less inspectors, or when inspection becomes the responsibility of one individual.

Inspection time is included in the total processing time that pharmacy personnel take to complete an order. The argument suggests that the additional time of the second inspector could be used more judiciously. In the case of Silas B. Hays Army Community Hospital, the outpatient pharmacy could use the second inspector more judiciously by employing his expertise in closer proximity to the computer terminals.

By positioning him there, the computer operators can be relieved of all problem solving issues.

The California Pharmacy Law, issued by the California State Board of Pharmacy, 1989, states that "a non-licensed person may type a prescription label but the responsibility for the accuracy of the prescription lies with the pharmacist who initials the prescription document." Further defined in section 4036.1 in the Business and Professions code, "there shall be no more than one non-licensed person for each pharmacist on duty in the pharmacy." [Ref. 10] In discussion with a pharmacy consultant in Monterey, California, studies have shown that the 1-1 ratio of non-licensed individuals and licensed pharmacists is adequate to maintain a satisfactory error rate. [Ref. 11]

For all practical purposes the second inspector should act as the floor supervisor. This person can be the problem-solver, the troubleshooter, the individual that keeps a defect from becoming a potential error. This supervisor can act as the pharmacy's expediter, ensuring that all efforts are made to alleviate any bottleneck in the overall process of dispensing medications.

IV. IMPROVEMENT STRATEGIES

Before implementation of any improvement there should be an examination of three measurements:

Throughput - the rate at which the system generates customer satisfaction; the delivery of prescribed drug orders to it's patients in a timely and error free manner.

Inventory - the prescription orders and raw materials (i.e., drugs, labels, and other materials supplies) in process which the system intends to convert into satisfied customers.

Operating Expenses - the total cost the system spends in turning inventory into throughput. [Ref. 12]

The measurements listed above should be consistent with the goals of the organization. These goals are now expressed in quantitative terms that can be fully measured and monitored on a continual basis.

The outpatient pharmacy manager can use the quantitative findings in this chapter and other chapters in deciding the necessary ongoing improvements to achieve the goals of the pharmacy.

In the true sense of manufacturing, a higher throughput rate equates to a higher return on invested dollars. The financial environment in the public sector, much like private industry, are forced to strive to achieve a greater fiscal responsibility.

In a service organization like Fort Ord's outpatient pharmacy, higher return on investment equates to better customer satisfaction. Operating expenses (i.e., interest cost, material handling costs, obsolescence, storage and space) can be reduced by keeping inventories low. Another goal for getting a better return on invested dollars and achieving greater customer satisfaction is saving the customer's time (a cost to society).

The pharmacy can keep operating expenses down by preventing current assets from being underutilized or wasted. This can be accomplished through the implementation of continuous process improvements.

Throughput, inventory and operating expenses are the three bottom line financial measurements that can be used to evaluate whether the strategies of an organization are moving in the right direction. The outpatient pharmacy should consider improvement strategies in which process efficiency can be adequately measured. The rules of sequencing are well known in the field of production operations and can reasonably measure the benefits of one method of order sequencing over the next.

A. PROCESS SEQUENCING

Patients arrive to the outpatient pharmacy at random and independently of one another. As they approach the front

window for service, they are served on a first come first serve (FCFS) basis. This simply means that their orders are being processed in the sequence in which they arrive.

Another possible order of sequence in which the outpatient pharmacy can process a customer's order is known as "shortest processing time" (SPT). That is, medication orders turned in are processed at the follow-on work stations by determining which order has the "shortest processing time."

"The shortest processing time is always superior in terms of minimizing flow time and hence, in terms of minimizing the average number of jobs at the work center and completion time." [Ref. 13]

The major disadvantage of SPT is that the processing time of a customer's order may not be obvious to the clerk at the front window or the operator at the computer station. A customer's order may get passed on to a follow-on work station as an SPT job when it could actually be very labor intense.

FCFS is not usually the most effective in that a job requiring a long processing time, tends to delay other jobs in the system. The shortest processing time method tends to make long jobs wait beyond a reasonable period of time before being processed. Therefore, modifications to SPT must be incorporated into the process in order to avoid these shortfalls. A floor supervisor must determine that if an order waits for a given period of time, that a job would be processed automatically so it could be passed on to the next work station. This

is referred to as a "truncated" SPT rule. [Ref. 14, This is a duplication of reference 13 above only different page number, p. 644.]

In Chapter II the bottleneck station suffers from high in-process inventory levels. Since SPT results in lower average time to complete a job, there should be less prescriptions in-process and the pharmacy can satisfy a greater number of patients.

Figure 4.1 is a description of a "model" pharmacy's processing time that later will show how the SPT procedure can be superior to a FCFS process.

In the "model" pharmacy example, a 30 minute rule will assume that a patient is not satisfied unless waiting time is 30 minutes or less.

<u>Work Description</u>	<u>Processing Time</u>
Over-The-Counter Medication	1 minute
Pre-Packed Medication	2 minutes
Medication available in a baker cell	3 minutes
Hand counted prescription item	4 minutes

Figure 4.1
The "Model" Pharmacy

Figure 4-2a depicts the number of prescriptions a customer turns in for processing, the processing time for each patient's order, the cumulative processing time and the

customer waiting time for 14 patients in a FCFS process. Figure 4-2b are comparative values for SPT.

The comparison between FCFS and SPT below assumes processing times in an aggregate sense rather than processing a batch of customer orders at 1, 2, 3, ..., n^{th} number of work stations.

The FCFS process was able to fill 6 customer orders within the established 30 minute rule. Using SPT, 9 customer orders can be filled. SPT meets the objective of maximizing production and satisfying a greater number of customers. SPT results in lower completion times and the outpatients pharmacy's level of work-in-progress can be reduced. A lower number of jobs at the computer station means more work at the filling station.

Throughput will increase to a level where the filling station has the capacity to produce customer orders. As long as the filling station does not become a bottleneck there will be less congestion at the work centers. Idle time at the filling station can be minimized by using an SPT system.

The level of customer satisfaction under a SPT sequence system is greater than the level of satisfaction under a FCFS system. In the "model" pharmacy under FCFS, there was 42.8% customer satisfaction. Under SPT there was a 64.3% level of customer satisfaction.

a. FCFS

Customer#	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A	2	1	3	1	1	2	3	1	3	1	2	2	1	3
B	2	3	6	7	8	10	13	14	17	18	20	22	23	26
C	5	3	11	2	4	7	11	2	9	4	5	7	3	9
D	5	8	19	21	25	32	43	45	54	58	63	70	73	82
E	0	5	8	19	21	25	32	43	45	54	58	63	70	73

b. SPT

Customer#	4	8	2	13	5	10	1	11	6	12	9	14	3	7
A	1	1	1	1	1	1	2	2	2	2	3	3	3	3
B	1	2	3	4	5	6	8	10	12	14	17	20	23	26
C	2	2	3	3	4	4	5	5	7	7	9	9	11	11
D	2	4	7	10	14	18	23	28	35	42	51	60	71	82
E	0	2	4	7	10	14	18	2	28	35	42	51	60	71

- A - # Customer Prescriptions
- B - Total # Prescriptions
- C - Processing Time
- D - Total Processing Time
- E - Customer Waiting Time

Figure 4.2
Comparative Sequencing

Nevertheless, note that both FCFS and SPT processes the same number of customers in the same amount of time. Both systems fill 14 customer orders are 82 minutes. SPT tends to make the customers with the longest processing time wait longer.

Therefore, customer orders with long processing times must be managed very carefully in an SPT "truncated" system. An order that spends too much time in a queue must be pushed at some point into the system and expedited. Alternatively, these customers should be advised to return at a later time.

Special cases may also merit inclusion of a long job out of SPT sequence. This leads us to consider a program to manage delay in filling customer orders.

B. DELAYED PRESCRIPTION PROGRAM

In a delayed prescription program the customer would be required to communicate to pharmacy personnel what time they intend to pick-up their prescription order. In some cases, the pharmacy would have to notify customers with large orders of the expected delay in filling their orders.

The process of a customer's order can then be accomplished according to the time it is due. In the case of customer orders with long processing times under an SPT system, the 30 minute rule designed to measure customer satisfaction would no longer be imposed.

Should there be a floor supervisor (as proposed in Chapter III), customer orders under a delayed program can be better managed. The supervisor could ensure that orders with long processing times are ready when the customer returns to pick-up their prescriptions.

A delayed prescription program addresses the time an order becomes due and can minimize lateness. The supervisor must ensure that the orders with long processing times do not wait too long. The longer an order waits increases the level

of prescriptions in-process and may cause congestion at work centers.

A large number of patients already choose to delay picking up their prescriptions. The data collected indicates that 39% of the customers elected to come back several hours after their orders have been processed. Twenty-five of those customers wait until the next day before picking up their order.

Suppose that in our "model" pharmacy a customer with three or more prescriptions, elected or was notified by pharmacy personnel that their order would be delayed one hour. This means that customers could not expect to pick-up their order any sooner. This would allow the pharmacy to fill orders for customers that are waiting in the lobby. The processing time for these customers would decrease significantly. Throughput measurements would increase remarkably.

When patients in the delay program return to the pharmacy and find their medication order ready (without further delay), the customer will be satisfied. If their order is not ready and there is an additional waiting time, they will be more inclined to formally complain about the service provided by the outpatient pharmacy.

C. ELIMINATION OF DOUBLE INSPECTION

Inspection time is added to the total processing time. Elimination of a second inspector would reduce the time it takes to produce customer orders. In Chapter III, experts in the field of human reliability and quality control suggest that the scanning of a prescription order looking for errors may incorporate biases away from the optimality of the search and cause irregularities in efficiencies. Furthermore, experts in the field of production operations state that "inspection is optimal when the sum of the costs of inspection and of passing defectives is minimized." [Ref. 15]

The higher proportion of human involvement does necessitate more inspection. For example, machine automation tends to be more reliable. Nevertheless, rather than having two inspectors examine the same item far down the production line, one inspector could be made to stop costly errors before they get passed on. In other words, it is better to avoid wasting expensive labor and machine time at the bottleneck on what is already defective. The second inspector could be better utilized if placed in closer proximity to the computer terminals. He could then be made more responsible for solving problems and troubleshooting them before passing them to a costly operation.

In this case, the inspector means more to the drug filling operation than just inspecting prescriptions. This

individual is actually facilitating operations that can increase the productivity of the outpatient pharmacy. This person in essence functions as the floor supervisor.

D. THE FLOOR SUPERVISOR

The supervisor's position emerges as the job of a quality manager. The difference in duties are mandated by the strategic goals of the pharmacy department. This job should be more oriented to the business aspects rather than to the actual filling of prescription orders.

The supervisor's duties and responsibilities would include concentrating managerial efforts on the system bottleneck:

- To insure two computer operator technicians are on station at all times.
- That the computer operators are not handling incoming or outgoing telephone calls. That this responsibility is designated to non-bottleneck workers.
- That computer operators process customer orders by the "shortest processing times" and that all customers in the delayed prescription program do not wait too long to have their prescription processed.
- That over-the-counter prescriptions are processed but not in front of customers that are waiting in line.
- Ensure pharmacy administrative reports are not executed during normal operating hours of the pharmacy.

Other supervisory duties and responsibilities would include:

- Handling problems and troubleshooting them prior to passing them on to the next work station. This would include problems at the service window, computer station and on the production line.
- Ensure that pharmacy technicians fill prescriptions by a computer generated label only. This is to avoid having the technician reclarify something that had already been resolved or misread a prescription. It also makes the technician's job easier.
- Monitor the delayed prescription program and initiate any action that results in elimination of additional inspection.

E. EXTENSION OF OPERATING HOURS AND SERVICES

The pharmacy department is presently unable to extend their hours of operations (Chapter I) mostly due to the lack of available staff personnel. Military enlisted personnel are required to stand additional duty, however, this duty is not pharmacy related. They stand a Charge of Quarters (CQ) watch and the more senior enlisted stand an Non-Commissioned Officer's watch.

The frequency of this duty varies depending on the rank of an individual. They stand their extra military duty about once every 4-6 weeks. A more judicious system would be to have these individuals stand their military duties in the pharmacy.

Policies that affect the hiring of additional labor are often beyond the control of operating managers. Additional hire of GS employees would alleviate the dependance the pharmacy has on the volunteer workforce and allow them to provide extended hours or additional services.

Some technological and conventional innovations can be helpful should the pharmacy be unable to hire additional workers:

- Voice mail telephone refill program (VMS).
- Interactive Voice Response system (IVR).
- Redesign of floor layout for pharmacy operations.
- Implementation of a Total Quality Management program.

Voice mail communications is finding its way in many business organizations including public agencies. A call processing system can deliver a caller's message verbatim into voice mailboxes. The system has what is known as an automated attendant. The caller can use a touchtone telephone to call in his prescription refill order. The system is PC (personal computer) based and with the proper hard drive and customized software can be very cheaply connected to existing telephone lines.

VMS is relatively inexpensive to purchase or lease. Most companies that sell the system will train staff personnel on how to operate the equipment. The cost for a 2, 4 or 8 port system is approximately \$8,000, \$17,000 and \$31,000, respec-

tively. The number of lines an organization needs to operate VMS determines the number of ports they must buy. [Ref. 16]

Another system known as Interactive Voice Response can be connected directly to an existing database. The advantage in using IVR is that action is taken by the software, and messages do not require additional handling. Call processing systems like VMS and IVR can free present pharmacy personnel and allow extended services to be offered.

In regard to the redesign of the pharmacy layout general recommendations are included in Chapter V of this thesis. Chapter VI is the guide for implementing improvements using a TQM approach.

V. MATERIAL HANDLING AND LAYOUT DESIGN OF THE PHARMACY

The outpatient pharmacy is a miniature factory that in essence has its own receiving department, production line and shipping area. In order to facilitate the flow of materials within the workplace, it is necessary to understand the relationship between the storage of material items and the pattern in which these items flow.

A. DESIGN LAYOUT ALTERNATIVES

Most production systems are arranged in either (1) a process format, (2) a product format, or (3) a combination of the two. An efficient facility layout structure means more time can be spent assembling and producing medication orders rather than moving the product line between stations. Production must always remain flexible. The production line must be able to properly adjust to changes in volume and workload. [Ref. 17]

Layout involves the placement of the departmental components of the pharmacy. They include the interdepartmental work stations, the baker cell machines that count pills automatically, and location and storage of the pharmacy's bulk and on-hand stock requirements. The outpatient pharmacy is a combination of the two formats described below.

Product Layout. A layout which is designed so components of the pharmacy are arranged in a progressive order by which a medication order can be filled.

Process Layout. A layout which components of the pharmacy are grouped according to the function they perform without regard to the medication or any particular drug.

There is a clear separation of functions in that one queueing line forms for prescription refills, and another line forms for new prescription orders. Similar progressive steps are performed by both of these functional components within the pharmacy. Personnel are assigned to one functional area, however, they often cross over to provide assistance to the other functional area. Generally, the majority of resources are dedicated to the functional component that handles the new prescriptions.

The pharmacy is operating two production lines. Baker cells are located on both lines and supply support is a mutual advantage. There is a similarity in production and assembly of drug order preparation. Figure 5.1 shows the general flow pattern of work through the two functional areas in the pharmacy.

The general characteristic of process design in the pharmacy is the presence of skilled labor. This is because of the need for highly specialized supervision for the large number of orders needing to be controlled or properly directed. In product layout the labor force is often unskilled or

semi-skilled. Personnel are cross-trained to do two more jobs and supervisors must be widely diversified and familiar with the entire operation. [Refs. 18, 19]

Refill Rx Orders		New Rx Orders
Incoming Order	:	Incoming Order
Station (1)	Window Service	Station (1)
:		:
Station (2)	Computer Terminals	Station (2)
:		:
Station (3)	Pharmacy Technicians	Station (3)
:		:
Station (4)	Pharmacists	Station (4)
:		:
	(5)	
	Rx Pick-up	

Figure 5.1
Functional Flow Pattern

B. STORAGE AND MATERIAL HANDLING

Frequently, the approach of solving a problem is to purchase a new machine. Material handling is often overlooked. The fact is, material handling may account for up to 25%-80% of all productive activity. [Ref. 20]

Material handling is concerned with efficient ways of moving material items (motion), the time it takes to process them and the amount of material required to get the job done.

Space requirements to store material is another important aspect of material handling.

All drug material items for the pharmacy are centrally located and in close proximity to the work place. There exists smaller stock availability in the pharmacy itself. This stock is very close to or directly located at the production assembly line. The number of times that stock is handled emphasizes its importance. Having materials stored nearby to where a prescription is filled, is critical in order to minimize the time it takes to fill a customer's order.

It is important to understand the relationship between the storage of materials and the pattern in which materials are to flow through the work place. The most effective flow pattern would be a straight line. The more bends and turns in the flow pattern, the more important it is to properly place the items that are going to be handled. In just a short time the benefits of a new conveyor at the pharmacy's production assembly line station are quite evident. Excessive material handling is eliminated from the order filling process.

VI. GUIDE FOR IMPLEMENTING IMPROVEMENTS: A TQM APPROACH

In military hospitals decreased budgets and the need for better and more efficient methods have managers scrambling to find better ways of doing business. Total Quality Management (TQM) is one approach to become more effective in achieving a higher level of performance and to provide greater satisfaction to all medical care beneficiaries in a region. Through the practice and application of TQM, a service department like Fort Ord's outpatient pharmacy would be able to better meet the needs of the organization and the needs of every patient.

TQM as described by the Federal Quality Institute, is a "strategic integrated management system for achieving customer satisfaction which involves all managers and employees, and uses quantitative methods to improve an organization's processes." [Ref. 21]

TQM itself must therefore be a continuous process of improvement activities involving everyone in an organization. This applies to activities beyond production. By using the various technical, statistical and managerial techniques available, an organization can integrate all of its quality improvement efforts.

In order to implement these improvements, the proper training of personnel is essential. Training must include managers and other appropriate members throughout the organi-

zation. TQM is an involved process and cannot be learned in a short period of time. It must be put into practice and utilized every day.

But TQM is not difficult. The objective is simply to analyze a process, think of a solution, and then implement that solution. Nevertheless, TQM is an on-going process and many organizations fail to understand this. The outpatient pharmacy must not only recognize what improvements can be made, but must create an environment of acceptance for making those changes.

Change for the sake of making a change is called tampering. The question should be asked, "Do we change something that does not need changing?" Every process has a natural inherent variability and statistically may be "in-control." But a process that is "in-control" does not always mean the process is operating at an acceptable level. [Ref. 22]

There is no set of procedures or standards that can be developed by an organization who wishes to implement TQM. Nevertheless, certain elements of managerial leadership, employee involvement and strategic planning must be made apparent if a TQM program is to succeed.

In the case of Silas B. Hays Army Community Hospital, the outpatient pharmacy presents an excellent opportunity to create, "A Process for Making On-Going Improvements for Dispensing Medication: Using a TQM Approach."

The philosophy, principles and evolution of TQM can be found in numerous articles and publications. A TQM workshop (of approximately 2 to 3 hours) could be developed. The National Contract Management Association, through their educational products division has developed an actual workshop (concentrated on procurement training) for conducting a TQM seminar in the workplace. Additional materials for training in TQM can be obtained from bookstores and/or libraries. The "Deming Library" is a series of videotapes on TQM with suggested readings that can facilitate discussion after viewing program materials. Workshops can easily be integrated into an organization's implementation plan. [Refs. 23,24,25]

A. A TQM IMPLEMENTATION PLAN

Implementation is a phase in which an organization takes action. When management has a clear understanding of the principles and practices of TQM, planning efforts can be approached systematically. [Ref. 26]

1. Phase I - Develop Managerial Understanding and Commitment for Total Quality Management

The fact that TQM is an organizational effort forces management to rethink their approach concerning quality. In order to be effective, management must have a clear understanding of the total quality management concept. They must

communicate their commitment to the overall process and educate employees of their role within the organization.

2. Phase II - Educate and Communicate the Employees of the Organization on the Philosophy and Principles of TQM

Development of process improvements, changes and system alternatives, can be accomplished with increasing success. Nevertheless, efforts of making these improvements do not come without expending energy, time and organizational resources. In order to minimize managerial efforts and maximize organization benefits, employee education on the philosophy and principles of TQM is essential.

3. Phase III - Development and Implementation of Improvement Strategies

Development and implementation of improvement strategies should be accomplished with the help and guidance of top management. At Silas B. Hays Army Community Hospital, the pharmacy department, with the help and guidance of the hospital's administration, can develop and implement the improvement strategies like those that can be found in Chapter IV.

4. Phase IV - Monitor and Maintenance of Improvement Process

Maintenance is always an important factor if an organization is to ensure continuous success. Improvements must be continuously monitored and the processes themselves can not be ignored or problems will inevitably occur.

B. SUMMARY

Silas B. Hays Army Community Hospital and the outpatient pharmacy strive to dispense all medications prescribed by proper authority at a zero error rate. This goal includes the delivery of all customer orders with the least possible delay. In order to achieve these goals and continue to deliver quality health care to its military members and their dependents, implementation of effective improvement strategies are essential.

This chapter is a guide for implementing improvements using a TQM approach. The outpatient pharmacy and other functional areas throughout the hospital can utilize this guide for purposes of developing a strategic integrating management system to achieve the goals of their perspective departments. Therefore, it is imperative that the commander and staff of the hospital be committed to the philosophy and principles of TQM at the early stages of its development. Only then can improvement strategies like those developed in Chapter IV be fully accepted by staff personnel.

The manager of the outpatient pharmacy must realize that improving the drug order filling process must be continuous. As education and communication of the TQM concept spreads throughout the workplace, employees will become more active in the creation of acceptable change. Monitoring and analyzing the process for ways to improve customer service will actually

be accomplished by the employees that work directly in a functional area. The manager must then evaluate all process change recommendations and plan the integration of any new improvement strategies.

Changes in scheduling priorities and the sequencing process of customer orders are strategies in which most patients can benefit from. Customers that participate in a delayed prescription program can help reduce long waiting lines and the time it takes to get a prescription filled. The heavy congestion in the main lobby of the hospital can be partly eliminated through management of the bottleneck station.

Finally, by cutting down on the number of errors that pass through the various stages of the drug order filling process, the pharmacy can achieve the kind of standards expected from them. Shigeo Shingo, a composer of some very popular models for making process improvements was once called "Doctor Improvement." Mr. Shingo was described as an individual who spent most of his time on the work floor observing problems. He made many valuable suggestions to management on how to improve processes. He was once quoted saying that "my medicine works, but only if the patient takes it." [Ref. 27]

APPENDIX A
REPORT OF PHARMACY QUEUEING STUDY

SAS							15:31 TUESDAY, JUNE 18, 1991 1	
OBS	QUEUE	PATCOUNT	ARRIVAL	RX	WINDOW	COMPUTER	RXFFILL	RXPICKUP
1	1	1	932	1	935	938	1003	1049
2	2	1	933	2	937	0	937	937
3	3	1	933	3	938	945	1007	0
4	4	1	935	1	939	940	1000	1102
5	5	0	935	1	939	940	1000	1102
6	6	1	936	1	940	941	1011	1018
7	7	1	936	1	941	942	1004	1015
8	8	1	936	1	942	944	1012	1012
9	9	0	936	1	942	944	1012	1012
10	10	1	937	2	945	0	945	945
11	11	0	937	3	945	948	1008	1012
12	12	1	938	5	945	0	945	945
13	13	1	938	1	946	947	948	0
14	14	1	938	1	946	947	1005	1137
15	15	1	939	3	948	951	1009	0
16	16	1	939	3	950	0	950	950
17	17	1	942	3	951	952	1010	0
18	18	1	942	1	955	959	1013	0
19	19	1	943	2	943	0	943	943
20	20	1	943	2	952	954	1012	0
21	21	1	943	2	953	956	1020	1211
22	22	1	944	2	957	0	957	957
23	23	1	944	1	958	1000	1022	1214
24	24	1	944	1	950	1003	1146	0
25	25	1	945	1	1002	1005	1026	1320
26	26	0	946	1	950	1004	1146	0
27	27	1	947	1	1003	1009	1028	1138
28	28	0	947	0	0	0	0	1138
29	29	1	948	1	948	1016	1043	1105
30	30	1	948	1	1012	1019	1039	1258
31	31	1	948	1	1015	0	1015	1015
32	32	1	953	4	954	957	1023	0
33	33	0	953	2	954	957	1023	0
34	34	1	953	1	955	958	1010	0
35	35	1	956	1	956	958	1023	0
36	36	1	958	1	1015	1018	1043	0
37	37	1	959	1	1018	1022	1044	0
38	38	1	959	1	1019	1020	1044	1308
39	39	1	959	2	1002	1007	1025	0
40	40	1	1000	3	1019	1024	1052	1220
41	41	1	1000	2	1000	1002	1029	1029
42	42	1	1002	2	1020	1024	1046	1152
43	43	1	1003	1	1003	1004	1036	0
44	44	0	1003	1	1003	1004	1036	0
45	45	1	1004	3	1021	1027	1052	0
46	46	1	1006	1	1023	1029	1052	1126
47	47	0	1006	3	1023	1029	1100	1126
48	48	1	1008	1	1010	1011	1037	0
49	49	1	1008	1	1029	1031	1110	0
50	50	1	1008	2	1029	1036	1101	1312
51	51	1	1008	3	1030	1041	1108	0
52	52	1	1009	2	1031	0	1031	1031
53	53	1	1009	1	1032	1046	1103	1238
54	54	1	1010	1	1010	1016	1054	0
55	55	1	1013	1	1016	1019	1040	0

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OBS	QUEUE	PATCOUNT	ARRIVAL	RX	WINDOW	COMPUTER	RXFILL	RXPICKUP
56	56	1	1013	2	1032	0	1032	1032
57	57	1	1017	1	1034	1050	1106	1151
58	58	0	1017	1	1034	1050	1106	1151
59	59	1	1017	1	1035	1048	1110	0
60	60	1	1017	1	1037	1050	1110	0
61	61	0	1018	1	1037	1050	1110	0
62	62	0	1019	2	1035	0	1035	1035
63	63	1	1019	2	1036	0	1036	1036
64	64	1	1020	4	1041	1053	1114	0
65	65	1	1020	2	1042	0	1042	1042
66	66	1	1023	1	1028	1031	1109	0
67	67	1	1024	2	1024	1030	1054	0
68	68	0	1024	2	1024	0	1024	1024
69	69	1	1025	1	1044	1054	1116	1201
70	70	1	1026	1	1043	1054	1117	0
71	71	0	1026	2	1043	0	1043	1043
72	72	1	1026	1	1044	1100	1122	1324
73	73	1	1027	1	1046	1056	1118	1145
74	74	0	1027	1	1054	1056	1118	1145
75	75	1	1026	4	1045	1056	1118	0
76	76	0	1026	1	1045	1056	1119	0
77	77	1	1030	2	1046	1058	1120	0
78	78	0	1030	3	1046	0	1046	1046
79	79	1	1031	1	1048	1058	1119	1643
80	80	1	1031	1	1109	1135	1209	1214
81	81	0	1031	0	0	0	0	1214
82	82	1	1032	1	1049	1059	1121	0
83	83	0	1032	0	0	0	0	0
84	84	1	1032	1	1050	1100	1124	1706
85	85	1	1033	1	1050	0	1050	1050
86	86	1	1035	1	1054	1106	1128	1146
87	87	0	1035	1	1054	1106	1128	1146
88	88	0	1035	2	1059	0	1059	1146
89	89	1	1036	1	1050	1102	1124	0
90	90	1	1036	2	1052	1105	1127	0
91	91	1	1027	3	1038	0	1038	1038
92	92	1	1037	1	1039	1045	1103	1105
93	93	1	1038	1	1051	1108	1132	0
94	94	1	1039	1	1052	1103	1125	1236
95	95	1	1040	1	1053	1105	1126	0
96	96	0	1040	1	1053	1105	1126	0
97	97	1	1041	4	1053	1112	1136	1153
98	98	0	1041	3	1053	1112	1136	1153
99	99	0	1041	3	1053	1112	1136	1153
100	100	1	1042	1	1100	0	1100	1100
101	101	1	1043	2	1054	1108	1131	1152
102	102	0	1043	3	1054	0	1054	1152
103	103	1	1045	1	1059	1114	1130	0
104	104	1	1045	1	1056	1108	1132	1201
105	105	1	1045	1	1102	1122	1158	0
106	106	1	1046	2	1101	116	1202	0
107	107	1	1049	1	1103	1124	1202	0
108	108	0	1049	1	1103	0	1103	1103
109	109	0	1049	2	1103	1131	1202	0
110	110	1	1050	1	1106	1123	1159	1643

REPORT OF PHARMACY QUEUEING STUDY (continued)

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08S	QUEUE	PATCOUNT	ARRIVAL	RX	WINDOW	COMPUTER	RXFILL	RXPICKUP
111	111	1	1051	1	1106	1124	1203	0
112	112	1	1052	1	1106	1130	1202	0
113	113	0	1052	1	1107	1107	1130	0
114	114	0	1052	1	1106	1130	1203	0
115	115	1	1045	2	1101	1122	1200	0
116	116	1	1054	1	1108	1115	1122	1123
117	117	1	1054	1	1111	1137	1208	0
118	118	1	1054	1	1111	1137	1208	0
119	119	0	1054	1	1111	1136	1208	0
120	120	1	1056	1	1058	1059	1109	0
121	121	1	1057	1	1113	1138	1209	0
122	122	1	1057	2	1114	1139	1212	0
123	123	1	1059	1	1115	1142	1223	0
124	124	0	1059	1	1115	1141	1223	0
125	125	0	1059	1	1115	1141	1223	0
126	126	1	1059	1	1116	0	1116	1116
127	127	0	1059	1	1102	1106	1118	0
128	128	1	1100	1	1116	1139	1220	0
129	129	1	1100	1	1116	1139	1209	0
130	130	1	1100	3	1117	1140	1214	0
131	131	0	1100	3	1118	0	1118	1118
132	132	1	1101	1	1118	1144	1224	0
133	133	1	1102	2	1120	1146	1223	1236
134	134	1	1103	1	1119	1145	1224	0
135	135	1	1105	3	1107	1112	1121	1122
136	136	1	1106	2	1120	1151	1226	0
137	137	1	1109	1	1111	1118	1157	0
138	138	0	1109	1	1111	1114	1122	0
139	139	1	1110	0	0	0	0	0
140	140	1	1110	5	1113	1122	1138	0
141	141	1	1112	2	1124	0	1124	1124
142	142	1	1112	2	1122	1152	1230	1233
143	143	1	1112	1	1122	1153	1231	0
144	144	1	1113	2	1123	0	1123	1123
145	145	1	1113	1	1124	1155	1232	0
146	146	0	1113	1	1123	1153	1230	0
147	147	1	1113	1	1123	1154	1230	0
148	148	1	1114	3	1123	1156	1235	1532
149	149	0	1116	2	1123	0	1123	1532
150	150	1	1114	4	1125	1159	1234	1313
151	151	1	1116	3	1126	1204	1237	1245
152	152	0	1116	4	1139	0	1139	1245
153	153	1	1117	3	1125	1207	1237	1325
154	154	1	1118	1	1128	1210	239	0
155	155	1	1118	2	1127	1208	1240	0
156	156	1	1118	1	1129	1217	1240	1729
157	157	0	1118	1	1129	1215	1240	1729
158	158	0	1118	1	1129	1214	1240	1729
159	159	1	1119	1	1128	1211	1240	1257
160	160	0	1119	1	1128	1213	1240	1257
161	161	1	1120	1	1130	1227	1245	0
162	162	0	1120	1	1130	1226	1241	0
163	163	1	1120	2	1130	1222	1241	1305
164	164	1	1121	1	1130	1225	1246	0
165	165	1	1122	1	1131	1226	1246	1543

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OBS	QUEUE	PATCOUNT	ARRIVAL	RX	WINDOW	COMPUTER	RXFILL	RXPICKUP	
166	166	0	1122	2	1130	0	1130	1543	
167	167	1	1123	1	1131	1235	1252	0	
168	168	0	1123	1	1131	1235	1252	0	
169	169	0	1123	1	1131	1235	1252	0	
170	170	1	1123	2	1139	0	1139	1139	
171	171	0	1123	1	1131	1235	1251	0	
172	172	1	1124	1	1131	1235	1252	0	
173	173	1	1124	1	1134	1229	1247	0	
174	174	1	1125	1	1136	1231	1248	0	
175	175	0	1125	1	1136	1231	1249	1312	
176	176	0	1125	1	1136	1232	1251	1312	
177	177	1	1126	1	1135	1230	1248	0	
178	178	1	1126	2	1136	0	1136	1136	
179	179	1	1127	4	1137	1236	1253	1530	
180	180	1	1127	1	1137	1237	1253	1514	
181	181	1	1128	1	1137	1237	1253	0	
182	182	1	1128	1	0	0	0	0	
183	183	1	1128	2	1138	0	1138	1138	
184	184	1	1129	1	1138	1240	1254	1302	
185	185	1	1130	1	1133	1134	1207	0	
186	186	1	1121	1	1121	1123	1138	0	

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